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Transmitted herewith are the papers required to enter the national state in the U.S. as a designated office/elected office for the following PCT international patent application:

INTERNATIONAL APPLICATION NUMBER: PCT/DE/03154
Int'l Filing Date: 28 September 1999
1st Priority Date: 1 October 1998
Inventor(s): Frank BRANDT
For: METHOD AND DEVICE FOR TRANSMITTING DATA OVER LOW-VOLTAGE NETWORKS

The United States Patent Office is: (select one)

___ A Designated Office (No Demand was filed - See 37 CFR 1.494)
_X_ An Elected Office (A Demand for Preliminary Examination was Filed - See 37 CFR 1.495)

Enclosed are:

_X_ A copy of the international application Request (if this line is not checked, the international application was previously communicated by the International Bureau or the international application was originally filed in the USPTO).
_X_ An English Translation of the International Application
_X_ An **UNEXECUTED** Combined Declaration and Power of Attorney
___ A translation of amendments under Article 34 PCT
_X_ A copy of the Notification of the Recording of a Change
___ A translation of annexes to the international preliminary examination report
___ An Assignment of the Invention to xxxxxxxxxxx (with $40.00 recordal fee)
___ Information Disclosure Statement, 1449 Form and cited references
___ A Preliminary Amendment—annotated copy of PCT/EP
___ Clean copy of application after annotations filed as Preliminary Amendment
_X_ A copy of the International Search Report and cited references
___ A copy of the References cited in the German Examination Report
_X_ A copy of the Preliminary Examination Report
_X_ PCT Published Application
_X_ Notification of the Recording of a Change
_X_ 7 Sheets of Formal Drawings

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FEE CALCULATION

X	BASIC FEE			$ 840.00
	(IPEA-U.S. $670/335; ISA-U.S. $760/380; PTO not ISA or IPEA $970/485; U.S. IPEA all claims meet 33(1)-(4) $96/48; File w/ EPO or JPO search report 840/420;)			
___	Surcharge for filing a late oath or declaration ($130/65)			$ ***
___	Surcharge for filing a late translation ($130)			$ ***
X	Multiple dependent claims ($260/130)		x $ 260 claim =	$ $260.00
___	Excess claims - see calculation below			
	Total Claims:	- 25 - 20 = 5	X $18/09claim =	$ 90.00
	Independent Claims:	- 1 - 3 = 0	X $78/39/ind. claim =	$ --
			Excess Claim Total	$ 278.00
___	Assignment recordal fee ($40)			$
			TOTAL FEES	$ 1,190.00

X The Commissioner is hereby authorized to charge the filing fee of $1,190.00 and any additional fees or credit any overpayment to Deposit Account No. 07-1445 (Order No. ZIMM0001). A duplicate copy of this transmittal is enclosed.

Please direct all correspondence concerning this case to the undersigned at **GLENN PATENT GROUP, 3475 Edison Way, Ste. L, Menlo Park, CA 94025.

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Method and arrangement for data transmission in low-voltage systems

This invention relates to a method according to the introductory clause of claim 1, and to an arrangement for implementing said method.

Utility companies have highly ramified power supply networks through which they are connected with their customers. This benefit has for a long time been utilized beyond mere energy supply, for example, for tone frequency remote control where data was transmitted in one-way communication systems though with the disadvantage that there was no feedback.

More recently, however, proposals were made to enable the use of the low-voltage systems of utility companies for two-way communication independent of other carriers. While one-way communication just allows the collection of data such as meter readings for electricity, gas, water, etc. or registration of measured values such as temperature, pressure, or alarms, two-way communication can be used to query switching states and to control complex technical facilities. In addition to regular data transmission, the low-voltage system that utility companies have and to which each household is connected can be used for plain ordinary telephone service. According to a known proposal of this kind, the power suppliers who use their low-voltage system for telecommunication have to provide, on the one hand, facilities that act as data filters to make sure that the data is received by its addressees only. On the other hand, devices are required at the network stations that transpose the data to a copper, cellular radio, or fiber network that connects the stations. It has been assumed as yet that about 100 to 200 households can be connected to one network

station. In compliance with the European Celenec EN 50065-1 standard, a theoretically usable data rate of up to 70 kbps would be available for data communication in duplex mode on a dedicated frequency band up to 95 kHz.

A two-way communication system for data transmission between a central station and end user facilities is known from DE 195 04 587. Node controllers linked to the low-voltage network function as substations, and a large-area telecommunication network such as a cellular data network or a circuit-switched network, in particular, an optical fiber network, is used for data transmission between the central station and the substations. The node controllers associated with the distributed network transformers are equipped with standard modems that provide an interface between the low-voltage and the large-area telecommunication network whereas a modem with repeater function is provided as an intermediate station on the transmission path between the node controller and the end user facility; data transmission within the local low-voltage system is based on the spread spectrum method.

Data transmission in low-frequency networks uses the frequency range up to 148.5 kHz that is permitted in Europe. However, one setback is that transmission quality is restricted in this frequency range due to numerous interference signals and a high noise level, another setback is that the narrow-band transmission frequency band is limited with regard to the number of subscribers and the bit rate per subscriber.

The older but not prior printed patent application DE 197 14 386.5 discloses a method for data transmission in two-way communication via low-voltage systems that are linked to a higher-order telecommunication network.

To combine a high data transfer rate with improved transmission quality as compared to conventional systems, transmission security in ISDN quality, and real-time signal processing, data transmission within the low-voltage system takes place at a high-frequency range of up to 30 MHz using band spreading of data signals and a transmitting level below the specified interference or noise voltage limit of line and radio disturbance characteristics, in that said band-spread data is given a direction coding to specify a logical direction within the low-voltage system using different sequences of a family of pseudo-random numbers to enable multiple-user operation, the binary sequences of data with their user-specific spreading and direction-specific coding being identified by correlation using specified sequences at attenuation-dependent distances within the low-voltage system, then said data sequences are regenerated and assigned new direction codes for forwarding.

The limits for radio and line frequency interference are much lower at a higher frequency range, e. g. 10 MHz, than in the frequency range up to 148.5 kHz. But narrow-band interference caused by harmonic waves from other frequency ranges occurs at this range, too, and even the standard radio transmitters interfere with data transmission at this frequency range. On the other hand, the specified maximum output levels, which are very low, must not be exceeded. Furthermore, a signal output at a low level may drop below the noise level due to transmission loss that increases with growing distance and frequency, so that non-spread signal can no longer be received.

Due to its low output level and the high attenuation at this frequency range, the signal to be transmitted would

drop below the noise level at a transmission loss of 50 to 70 dB/100 m but in buried cables it can be received below noise level and successfully regenerated at a distance of 100 m. A direction coding using code, time, or frequency multiplexing converts the physical separation which is impossible with data transfer in low-frequency systems into a logical separation, thus enabling duplex operation. Code multiplexing also ensures a multiple-user structure. As direct sequence band spreading is used where, instead of a single information symbol, a sequence of pseudo-random numbers is transmitted in the same time, the bandwidth required for transmission increases by a factor that corresponds to the sequence of pseudo-random numbers. In this way, narrow-band sources of interference and frequency-selective attenuation properties lose their influence on the transmission method.

This older method of data transmission at a high frequency range facilitates low-cost bidirectional data transmission in real time via the low-voltage systems of utility companies if buried cables are used. Transmission channels in ISDN quality with a data rate of 64 kbps can be provided, and the overall transmission capacity of the low-voltage line between connected users and the interface between low-voltage system and higher order telecommunication network is a minimum of 2 Mbps for each the forward and back channel with a bit error rate of 10^{-6} over 100 m.

Despite the advantageous properties of the older method listed above, said method is subject to several limitations that stand in the way of its purpose. It is therefore the problem of this invention to improve the older method in the fields of transmission quality and security, and to extend its field of application.

This problem is solved according to the invention by the features specified in the characterizing clause of claim 1. Advantageous further developments can be derived from the subclaims assigned to it.

The invention is characterized in that data transmission in the low-voltage system takes place at a high-frequency range above 148.5 kHz using band spreading of data signals and a transmit level below the interference or noise voltage limit of line and radio disturbance characteristics applicable to the method described, and in that said signals that are spread over a frequency band or time range using different sequences of one or several families of numeric numbers to enable multiple-channel operation are given a direction coding, frequency or channel assignment to specify a receiver-specific logical direction within the low-voltage system, said binary data sequences spread in a channel-specific way within the low-voltage system being identified, regenerated, and reassigned new direction codes for forwarding based on the specified sequences using correlation, iterative, or parallel fault signal suppression methods or time/frequency transformation depending on attenuation.

The method described in the older patent application DE 197 14 386.5 is based on an obligatory link of the low-voltage system to the higher order telecommunication network. This results in disadvantages regarding flexibility for purely low-voltage insular networks. All communication processes would always be run via the higher order telecommunication network that is regarded as public and would therefore be billed to the user.

Furthermore, distinctions can be made between using the low-voltage systems for bridging the so-called "last mile," i. e. accessing user premises by bridging the gap between low-voltage network stations and house networks, and a purely in-house use of low-voltage systems.

Thus without being linked, either directly or via the "last mile," to a higher order telecommunication network, LAN solutions are facilitated that provide a local network when used in-house or on private property which the user can independently operate for voice and data communication - without having to use the service of a public network operator that is subject to fees. Such a standalone partial communication network can be able to match for a comparable Ethernet (10 Mbps) in bus topology depending on the quality of the system and its dissipation characteristics.

The system layout depends on the size of the local network: it either represents its maximum buildout (one network with repeater unit (SAE), user terminal connection unit (EGA), and network interworking unit (NÜG)), said NÜG being supplemented by a network monitoring, switching, and control function, or its minimum buildout where it would just have a signal conditioning and switching unit (SAVE) to which the EGAs are connected via the low-voltage line.

Furthermore, the method described in the older patent application limits the use of low-voltage systems for two-way communication to a frequency range up to 30 MHz. This is disadvantageous with a view to the various external and in-house applications. A limitation to specific frequency ranges would not be useful because the network properties at high frequency ranges are not explicitly disadvantageous for the method described.

Therefore the transmission frequency range is generally unlimited for this invention. In practical applications, however, it will usually be below 30 MHz and in some route sections, for example, for decoupling partial networks, come up to 60 MHz depending on the type of cable used, the network structure, and the dissipation properties of the low-voltage line.

The method described in the older patent application is based on a multiple-user structure to be created by suitable measures. But especially with a view to the potential separation of "last mile" and in-house low-voltage systems, the method of the invention may be restricted in use if exclusively a multiple-user structure is used. Pure in-house networks do not have a multiple user structure because there is just one user but several user terminals; however, the desired communication among the multiple user terminals could be based on a multiple-channel structure.

The method of band spreading as described in the older patent application using a family of pseudo-random numbers was improved by introducing spreading using various sequences of one or several families of numerical values. The multiple channel structure is achieved by overlaying the spread signals with different sequences, either as a synchronous or as an asynchronous overlay. The optimum sequence of number families can be defined based on the economic and engineering synchronization requirements to be met. Furthermore, multiple channels can also be implemented, either alternatively or in addition, by time and/or frequency multiplexing designs.

Finally the measures of the method according to the invention described below can enhance the call handling

capacity of the method described in the older patent application and thus improve its importance as a major system factor for safe detection of the useful signal within the noise range.

A receiver operates based on the correlation method by correlating a time- or frequency-spread signal with the reference signal, the result being integrated over the decision period of one spread period, and a threshold detector is used to decide on a logical status. A frequency-spread signal spread over several subcarriers has to be converted on the receive side by a time/frequency transformation for which a Fast-Fourier transformation or a Fast-Hadamard transformation would be most suitable. It is advantageous to combine these two methods so that the symbol duration of a data bit can be extended by splitting over several subcarriers, such extension being most effective if it corresponds to the duration of the receiver signal widening that occurs in the transmission channel.

To further improve a receiver for a low-voltage transmission method, a method for iterative or parallel fault signal suppression and a chip-synchronous transmission method can be provided. This method is known as joint detection and is used to detect multiplexed signals. Known signals can be calculated by correlation from the received signal, the sequences of said signals being specified between the transmitter and the receiver and thus the reference signals are known to the correlator.

Furthermore, the time/frequency transformation or analytical digital signal processing can be used to determine other signals that interfere with the useful signal and filter them out by calculation using the joint detection method, thereby improving signal quality detect.

Switching facilities can be placed at the interface to a potential higher order telecommunication network or the "last mile" and an in-house network that have a similar function and layout like private branch exchanges used in today's POTS networks or routers used in LAN environments. These facilities are not required for the method of the invention but the may be a useful supplement of the arrangement proposed that increases convenience for the user and provides some features of communication systems for independent operation by the users, which is cost effective as no public network providers have to be used.

In a further development of the invention, a family of number sequences such as Gold or Walsh-Hadamard sequences is used for user-specific band spreading. To prevent mutual interference of users or their terminals, different families of pseudo-random sequences are used in the various network areas.

In an advantageous embodiment, the logical direction of the data stream is preset using code multiplexing, i. e. multiplying the data stream by Walsh sequences the length of which is shorter than that of the band spreading sequences. Alternatively, additional multiplication by Walsh sequences can be left out when specially selected and number sequences are used for direction coding that differ in different network areas. The benefit would be reduced signal processing requirements in real-time signal processing but increased channel management requirements.

According to another feature of the invention, the forward and backward directions can be divided to indicate a logical direction in a low-voltage system using time and/or frequency multiplexing; here, the band-spread signals are

transmitted in the transmit and receive directions on separate frequency bands or time slots.

First, in the initializing phase prior to the actual data transfer, an initializing sequence plus user ID and a logon sequence are output, and a spread sequence is assigned to the user terminal by means of the user ID.

The arrangement of the invention for carrying out the method consists of a low-voltage system with integrated user terminals, local line distributor boxes and network stations as well as a higher order telecommunications network, with network interworking units being assigned to the network stations to link the low-voltage system and the higher order telecommunications network and for channel assignment in the respective transmission medium, and with amplifier units being placed at specific distances in the low-voltage system for regenerating and direction-specific forwarding of the data signals to a subsequent amplifier unit or to a user terminal or to a network interworking unit.

A CDMA processor for spreading the data using its allocated spread sequence and adding the direction code, a modulator for modulating the signals onto a carrier frequency, a controllable amplifier to adjust the input level required at the receiving end for optimum correlator performance, and a physical coupler for feeding the spread and direction-coded data stream into the low-voltage system are assigned to the user terminal. The receiver structure consists of a controllable low-noise input amplifier, an IQ demodulator, an equalizer, preferably a rake receiver, and a CDMA processor for despreading the data signals. The non-spread data signals are conditioned for transmission by a channel encoder/decoder in the base band, e. g. a

encoder and a Viterbi decoder. A data multiplexer/demultiplexer passes the data on to the voice and data interface that can be configured for any common interface type (e. g. S_0, analog a/b, Ethernet). The user terminal has a device ID and an additional SIM (Subscriber Identity Module) allowing partially mobile use of the system. All components are controlled by a microprocessor and a centralized clock generator. The clock signal is synchronized using the data signal received. The transmit and receive signals are fed via a filter or a frequency separator into a physical coupler that also supplies power to the user terminal. In the event of a power failure, operation can be continued for a limited period of time.

The repeater units integrated into the low-voltage system at local line distributor boxes, lamp posts, or, optionally, in house connection boxes include the same functional groups as the user terminal but the functional groups of digital signal processing (equalizer, CDMA processor, channel encoder/decoder) and, optionally, parts of the clock generating unit are configured in accordance with the number of channels to be regenerated multiplied by the number of signaling directions. The error-corrected data signals are fed from the channel decoder into the next channel encoder either directly or via a switching matrix. A device ID is also implemented in the system - like in the user terminal. In addition, the repeater units are characterized in that a value memory is integrated into the system in which the current channel assignments and the associated direction codes and sequence to be used as well as other signal source and sink information are stored. This value memory is managed through the microprocessor.

The network interworking units include the same functional groups as a repeater unit but multiple functional groups of

digital data processing (equalizer, CDMA processor, channel encoder/decoder) are configured in accordance with the number of transmission channels to the higher order telecommunication facility provided plus the number of synchronization channels required per low-voltage system. Furthermore, there are multiple physical couplers and front ends towards low voltage configured depending on the number of network areas to be supplied.

The decoded data signals are fed via a switching matrix into the transmission system that converts the signals on the telecommunication network side into n * 2Mbps transmission systems for copper, optical fiber lines, or cellular radio connections, n being dependent on the demand and capacities available and as a rule representing a number between 1 and 3.

Furthermore, a microprocessor system assigns the channels in the network interworking unit by configuring the switching matrix and the CDMA processors. The network interworking unit also has a device ID and a value memory in which the data of all active connections consisting of routing information, channel assignment, signal quality during the connection, user terminal ID, services used, and the assigned transmission channel are stored. Optionally, data rate and protocol adjustment systems can be placed between the switching matrix and the transmission facility to the higher order telecommunication network which adjust potential current or future data formats for a data service to the system structure of the data transmission system on the telecommunications side.

Other features and useful developments and advantages of the invention are described in the subclaims and in the embodiment described below.

An embodiment of the invention shall be explained in greater detail based on the enclosed drawing comprising:

Fig. 1 the structure of the communications network based on a typical low-voltage system;

Fig. 2 a block diagram of a user terminal;

Fig. 3 a block diagram of a repeater unit with one physical coupler;

Fig. 3a a block diagram of a repeater unit for several physical couplers;

Fig. 4 a block diagram of a network interworking unit;

Fig. 5 a diagrammatic view of the coding of data streams to indicate a logical direction in the low-voltage system;

Fig. 6 a diagrammatic view of the coding of frequency assignment and the definition of points of reference for level control;

Fig. 7 a block diagram of the functional components of the higher order telecommunication network; and

Fig. 8 a diagrammatic view of the attenuation measures against interfering inputs at a local line distributor box with connection options for repeater unit or a network interworking unit.

The basic structure of the communications network according to the invention is that of a low-voltage system. Network stations 1 are connected to local line distributor boxes 3 via low-voltage lines 2 in this communications network. Branch lines 4 leading to the individual users 5 are connected to the low-voltage lines 2 between local line distributor boxes 3 or between a local line distributor box 3 and a network station. The length of the low-voltage line 2 between two local line distributor boxes 3 depends on building density and is about 100 m for areas with high-rise blocks, 200 m with street-lining apartment blocks in the city, and up to 500 m in areas with detached houses. The users 5 are just depicted as an example in Fig. 1; their number is much greater in fact. To function as a data transmission network, user terminals 6 are assigned to the users, and the data from these terminals is transmitted via low-voltage lines 2 and repeater units 7 tapped into them to the network interworking units 8 that are usually located close to the network station 1, or in reverse direction. Alternatively, the network interworking unit can be connected to any point on the low-voltage lines 2, for example near the local line distributor boxes 3, as long as this tapping point is favorably located for connection to the higher order telecommunication network 48.

An embodiment of a user terminal 6 according to Fig. 2 basically consists of an interface functional group 40, a digital signal processing system 36, a front end to low voltage 39, and a microprocessor system 38, each of these groups being in an area delimited by dot-dash lines. It includes the following components: a CDMA processor 18 with a multiplier 17 and a amplifier 22, a modulator 9 and a physical coupler 10, the input arrangement including a low-noise input amplifier 23, an IQ demodulator 11, an equalizer 24 and the CDMA processor 18 with integrator 12

and threshold detector 13. Furthermore, a channel encoder /decoder 25, a data multiplexer/demultiplexer 26 for transferring the data to a data interface 28, and a voice and operating interface 27 are provided. The user terminal 6 further comprises a device identification unit 29, a SIM (subscriber identity module) 30, a microprocessor 31, and a clock generating unit 32, the synchronization and clock signals being shown as arrows and labeled 33. The terminal is connected to the low-voltage line 2 via a frequency separator or filter 34 and the physical coupler 10; said low-voltage line 2 also feeds the power supply unit 35 of the user terminal. The reference symbols 19, 20, and 21 represent either the spread sequence as marked by an arrow, or the direction code, or the carrier frequency, respectively.

The network interworking unit 8 represents the interface between the low-voltage communications network and the network that is commonly used for data transmission (not shown here) such as a cellular radio, telecommunication, or optical fiber network. Thus the network interworking unit 8 is to concentrate the data from the low-voltage system and to transmit them via the telecommunication network 48 to a switching center or feed the data received from said switching center into the low-voltage system for transfer to the user terminals 6.

For data transmission using the spread spectrum method, the user terminal 6 sends the data signals that are conditioned using an individual sequence of numbers to the next repeater unit 7 where the data received is detected by correlating the data stream with the number sequence assigned to the respective user terminal 6. The repeater units to be provided for data regeneration on the path towards the user terminals 6 are about 100 m apart with

buried cables and placed in local line distributor boxes, lamp posts, or house connection boxes. In housing areas where cables are highly branched and where additional meters, household devices, etc. are connected, signal conditioning will be required at distances of 20 to 30 m due to the great attenuation.

Voice and data transmission in this low-voltage system takes place in a frequency band of above 148.5 kHz using the direct sequence spread spectrum method and code multiplexing in order to suppress the influence of narrow-band sources of interference and to bridge long distances with low signal power, if possible without intermediate signal regeneration, and to be able to detect noisy signals for long ranges, and to allow simultaneous data transfer by multiple users. Each user terminal 6 uses its own sequence of numbers for data transmission in this code multiplex system which the higher order telecommunication system assigned to it via the network interworking unit 8 because the number of such sequences is not unlimited. These number sequences are not selected arbitrarily but from a family of codes, for example, a family of Gold sequences as the number of available sequences having a specific length is quite large here. This reduces the mutual interference of user terminals 6 to a minimum.

A user terminal 6 communicates with the network interworking unit 8 as required for initialization via the nearest repeater unit 7 where said user terminal 6 logs on using a signal that represents a number sequence reserved for this purpose, the so-called initialization sequence. The surrounding repeater units 7 respond to this initialization sequence with an identifier for the repeater unit 7, its distance from the nearest network interworking unit 8, and the ID of this network interworking unit.

In the figure showing the functional components of the higher order telecommunication network 48, the switching matrix is labeled 56, the transmission paths to subscribers are labeled 58, a transit point is labeled 57, and the microprocessor unit is labeled 59. The network interworking unit 8 that was addressed first forwards the initialization of the new user terminal 6 to the higher order telecommunication network 48 which registers the location data of the new user terminal 6. Similar to processes in cellular networks, the home location of the user terminal 6 can be logged on to a central home location register 49 of the higher order telecommunication network 48 (Fig. 7) via the central data query of a SIM 30 of the user terminal 6, and the respective current location can be stored in a visitor location register 50 when a user moves or uses his terminal as a partly mobile phone. These registers are kept and managed at a central point of the higher order telecommunication system 48. The visitor location registers 50 list important subscriber data and the repeater units 7 or network interworking units 8 that are placed in the direct surroundings of a user terminal 6. When a user terminal 6 is in its initialization process or when a call to or from said user terminal is being set up, the switching center uses the register information from the home location and visitor location registers 49, 50 to detect the current location, and a server 51 where all repeater units 7 and network interworking units 8 of a supply area are registered calculates at least the three shortest possible routings. The central monitoring stations 52 assigned to the network interworking units 8 check the possible transmission paths as determined by the server 51 for traffic load carried. The most favorable route is selected. Alternatively, the server 51 calculates new paths. The network interworking unit 8 and repeater unit 7

determined in this way reserve the individual pseudo-random number sequences (spread sequence "19") required in each network area 2.1, 2.2 (Fig. 1) for the transmission channel requested because the user terminal 6 has not yet been assigned a sequence of its own during initialization. The individual families of pseudo-random sequences are specified by the higher order telecommunication network 48 for each network interworking unit 8 and repeater unit 7 in a network configuration process. In addition to specifying the optimum transmission path, the higher order telecommunication network 48 also checks access rights and device ID in a check register for subscriber authorization 60 and a check register for terminal approval 61 during initialization.

After the user terminal has been released, it receives a spread sequence selected either by the network interworking unit 8 or the repeater unit 7 from a family of Gold sequences. To prevent signal interference in a repeater unit 7 connected to multiple network interworking units 8 communicating with other user terminals 6, adjacent network interworking units 8 are assigned different Gold sequences by the higher order telecommunication network 48. This minimizes mutual interference of two user terminals 6 that do not communicate with the same network interworking unit 8. The spread sequence sent out to a user terminal 6 is accompanied by the device ID so that another user interface that is just initializing cannot claim these pseudo-random sequences for itself. At the end of the initialization process the user terminal 6 sends a reception acknowledgment that already is spread using the assigned number sequence. A user terminal can also initialize immediately after it has been switched on. Then it is assigned a pseudo-random sequence even without data transfer. On the other hand, initialization can be carried

out when there is a communication demand, but in this case communication can be started from the terminal only. A third option would be a minimum initialization when the user terminal 6 is switched on while a pseudo-random sequence is assigned prior to a data transfer only.

The user data is spread for data transmission using the spread sequence assigned to the user terminal (see the block diagram of a user terminal 6 in Fig. 2). Furthermore, a sequence family is assigned or the data stream is multiplied by a Walsh sequence to indicate a data stream direction to enable data transfer through the low-voltage system in the desired direction. The binary data sequence produced in this way is modulated onto a carrier frequency by a modulator 9 assigned to the user terminal 6 and then fed into the low-voltage line 2 via a physical coupler 10 for transfer to a repeater unit 7.

The block diagram in Fig. 3 shows a repeater unit 7 and, vis-à-vis from the user terminal 6 in Fig. 3, shows a modulator 14 and a value memory 37 assigned to the microprocessor system 38. The data input at a physical coupler 15 is retrieved using a demodulator 11, an equalizer 24, an integrator 12, and a threshold generator 13. The regenerated data is again spread using the sequence assigned to the user terminal 6 and coded, for example, with a Walsh sequence to indicate the transmission direction. A carrier frequency is modulated with the binary data in the modulator 14, and the signal thus processed is output via physical coupler 15.

The repeater unit shown in Fig. 3 is designed for signal conditioning in a low-voltage through line. In principle, this component can be used in local line distributor boxes 3 or in network interworking units 8 when utilizing

crosstalk effects, but then attenuation measures as shown in Fig. 8 are recommended. The network areas that are decoupled in this way will then have to be linked via a repeater unit according to Fig. 3a that requires a separate physical coupler 15, front end for low voltage 39 and signal processing system 36 for each network area. The regenerated data is assigned to the correct network areas via a switching matrix 41 (Fig. 3a).

The network interworking unit 8 shown in Fig. 4 is similar in structure to a signal processing unit but supplemented after the switching matrix by a transmission system 42 to the higher order telecommunication network 48. A data and protocol matching system 44 that matches the data signals from the low-voltage side to existing protocol structures of a higher order telecommunication system (such as Dect backbone structures) may optionally be assigned to the network interworking unit.

The process of signal conditioning using the spread spectrum method and code multiplexing is repeated until the signal has covered the distance between the user terminal 6 and the network interworking unit 8 in one or the other direction. Data transfer from the user terminal to the network interworking unit is just slightly different from the data transfer in the opposite direction. The routes for both directions are selected by the server 51 located in the higher order telecommunication system 48 and transmitted via the network interworking unit 8 and the repeater unit 7.

Fig. 5 shows the principle of direction coding of the data streams using selected sequence families or Walsh sequences which are shorter than the spread sequences used. Identification of the data streams is explained based on

Walsh sequences; for example, data to be sent from repeater unit 7.1 to from repeater unit 7.3 may be given the direction code R3. Repeater unit 7.2 can detect the data with this R3 direction code (see Fig. 5) and assigns the direction code R5 to it after regeneration. The signal coded in this way and sent out will only be regenerated by repeater unit 7.3 and forwarded to the next repeater unit with the new direction code R7. As the physical medium used here, unlike other communications networks, cannot be separated in the repeater units, the coded data streams are also received by other repeater units but neither regenerated, nor coded, nor sent out again. This means that the respective repeater units only process signals that have the specific direction coding they are meant for. Thus the repeater unit 7.1 receives the data streams R5 and R2 as regenerated and coded by the repeater unit 7.2 but does not condition them because it only detects data streams with the direction codes R1 and R4 (see Fig. 5). In this way, the physical separation that is impossible under these conditions is converted into a logical separation.

The same physical separation also applies to signals that are to reach the user terminal 6. In the arrangement shown in Fig. 5, the repeater units 7.2 and 7.4 and the user terminal 6 are configured in such a way that the latter is fed and queried by the repeater unit 7.2. These transmit signals with the direction code R2 are regenerated by the repeater unit 7.4 except the direction code R2.1 which is addressed to the user connected to this section and is therefore not considered for regeneration in 7.4. The paths on which a signal is received and, optionally, regenerated and repeated are set by the central server 51 in the higher order telecommunication system 48.

Fig. 6 shows the principle of direction splitting for the forward and back directions of two frequencies. The repeater unit 7.1 exemplifies that input signals are only transmitted on frequency f2 whereas output signals in all directions are transmitted on frequency f1. The transmit and receive frequencies are vice versa for the adjacent repeater unit 7.2. If the repeater units are arranged in a ring shape, there must be an even number of systems, and alternatively two other frequency bands have to be used for data transmission. Direction division using frequencies is required because otherwise transmit and receive signals would overlay, and the receive correlator be blocked by a transmit signal that is too high. To improve the signal/crosstalk ratio at the receiver end, all output repeaters for all transmit signals must be adjusted to the level of the most remote receiver. If the repeater unit is 7.1, all transmitters on frequency f2 have to be adjusted to the Uel level at the receiver of the repeater unit 7.1 The principle of direction division for forward and back directions can alternatively be implemented using a time division multiplexer, a time buffer being required between the time slots for forward and back direction.

According to Fig. 8, high-frequency attenuation elements 55 are provided between the line terminals 46 in the local line distributor box 3 and a tapping point 47 in an unspliced section of the low-voltage cable when local line distributor boxes 3 are highly ramified to reduce the effect of interfering voltage inputs as shown by the arrow 55. A physical coupler 15, 16 to which the repeater unit 7 and the network interworking unit 8 are connected is connected via a feeder to each tapping point 47.

List of reference symbols

1	Network station
2, 2.1, 2.2	Low-voltage line
3	Local line distributor box
4	Branch line
5	User (house connection box)
6	User terminal
7, 7.1, 7.2	Repeater unit
8	Network interworking unit
9	Modulator of 6
10	Physical coupler of 6
11	Demodulator
12	Integrator
13	Threshold control
14	Modulator of 7
15	Physical coupler of 7
16	Physical coupler of 8
18	CDMA processor
19	Spread sequence
20	Direction code
21.1, 21.2	Carrier frequency
22	Controllable output amplifier
23	Controllable low-noise input amplifier
24	Equalizer
25	Channel encoder/decoder
26	Data multiplexer/demultiplexer
27	Voice and operating interface
28	Data interface
29	Device ID unit
30	SIM (subscriber identity module)

31	Microprocessor
32	Clock generating unit
33	Synchronization/clock signal
34	Frequency separator, frequency filter
35	Power supply unit or emergency power supply unit
36	Digital signal processing system
37	Value memory
38	Microprocessor system
39	Front end to low voltage
40	Interface functional groups
41	Switching matrix
42	Transmission system
43	-
44	Data rate and protocol matching system
45	-
46	Line terminal in 3, interfering source input
47	Tapping point, input for data transmission
48	Higher order telecommunication network
49	Home location register
50	Visitor location register
51	Server
52	Centralized monitoring station
53	Branched cable system
54	Noise voltage input
55	Attenuation element
56	Switching network in 48
57	Transit point
58	Transmission path to subscriber
59	Microprocessor unit in 48
60	Check register for subscriber authorization
61	Check register for terminal approval
R1, R2 etc.	Direction codes
f1, f2	Modulation frequencies
Ue1, Ue2	Receiving levels

7/PRTS

Cenglish translation of PCT Appl. 09/806784

JC08 Rec'd PCT/PTO 30 MAR 2001

We claim:

1. A data transmission method for two-way communication using low-voltage systems, either with or without a link to a higher order telecommunication, voice, or data network, characterized in that transmission within the low-voltage system takes place at a high-frequency range above 148.5 kHz using band spreading of data signals and a transmit level below the interference or noise voltage limit of line and radio disturbance characteristics applicable to the method described, and in that said signals that are spread over a frequency band or time range using different sequences of one or several families of numeric values to enable multiple-channel operation are given a direction coding, frequency or channel assignment to specify a receiver-specific logical direction within the low-voltage system, said binary data sequences spread in a channel-specific way within the low-voltage system being identified, regenerated, and reassigned new direction codes for forwarding based on the specified sequences using correlation, iterative, or parallel fault signal suppression methods or time/frequency transformation depending on attenuation.

2. The method according to claim 1, characterized in that a Fast-Fourier transformation is used for time/frequency transformation.

3. The method according to claim 1, characterized in that a Fast-Hadamard transformation is used for time/frequency transformation.

4. The method according to claim 1, characterized in that a combination of a Fast-Fourier and a Fast-Hadamard

transformation is used for time/frequency transformation.

5. The method according to one of the preceding claims 1 through 4, characterized in that a distinction is made between communication only within a low-voltage system or via a telecommunication, voice, or data network linked to it.

6. The method according to one of the preceding claims 1 through 5, characterized in that the useful signals in the signal received are identified by the joint detection method.

7. The method according to claim 1, characterized in that the channel-specific band spreading of the data signals is carried out using one or several matched families of number sequences such as Gold, Walsh, or Hadamard sequences.

8. The method according to claim 7, characterized in that adjacent families of number sequences of do not contain similar sequences to prevent mutual interference of users located in different network areas.

9. The method according to one of the preceding claims 1 through 8, characterized in that the data stream is multiplied by a Walsh sequence after band spreading using the direct sequencing method to give the data stream a logical direction in the low-voltage system.

10. The method according to claim 9, characterized in that the length of the Walsh sequences used for direction coding is smaller than the band spreading sequences used.

11. The method according to one of the preceding claims 1 through 8, characterized in that the logical direction of the data stream in the low-voltage system is identified by controlled and structured assignment of select families of number sequences to individual network areas that are enclosed by two repeater units or by one repeater unit and a network interworking unit.

12. The method according to one of the preceding claims 1 through 8, characterized in that directions are separated using time or frequency multiplexing and that the band-spread signals are transmitted in the transmit and receive directions on separate time slots or frequency bands.

13. The method according to claims 1 through 12, characterized in that the transmit levels of each transmitting unit in a network area are set in such a way that all overlaid signals of one frequency comprise nearly the same level at the receivers of the repeater or the network interworking unit in the controlled period.

14. The method according to claims 1 through 8, characterized in that prior to the actual data transfer, an initializing phase is provided in which an initializing sequence plus the ID of the respective user and of the user terminal and a logon sequence are output, and a spread sequence is subsequently assigned to the respective user.

15. The method according to claim 9, characterized in that the IDs of the respective user and the user terminal

are checked for device approval of the terminal and communication authorization of said user in the higher order telecommunication network after sending out the initialization sequence.

16. An arrangement for carrying out the method according any one of the preceding claims 1 through 15 consisting of a low-voltage system, users connected to it via user terminals, local line distributor boxes and network stations, and a higher order telecommunication network connected to said low-voltage system, characterized in that network interworking units (8) are assigned to the network stations (1) to connect the low-voltage system and the higher-order telecommunication network (48) and for channel assignment in the respective transmission medium, and that repeater units (7) are placed at specific distances within the low-voltage system, said units being designed for regenerating and direction-specific forwarding of the data signals to a downstream repeater unit or a user terminal (6) or a network interworking unit (8).

17. The arrangement according to claim 16,characterized in that the user terminal (6) is associated with the following functional units: physical coupler (10), frequency separator or filter (34), controllable low-noise input amplifier (23), IQ demodulator (11), modulator (9), controllable output amplifier (22), equalizer or fault signal suppressing unit (24), CDMA processor (18), channel encoder/decoder (25), voice/data multiplexer (26), voice and operating interface (27), data interface (28), SIM (subscriber identity module) (30), device identification unit (29), microprocessor (31), central clock generating unit (32), synchronization facility (33), emergency power

supply unit or power supply unit (35) and controllers for controlling the input and output levels.

18. The arrangement according to claim 17, characterized in that a CDMA processor (18) is provided for spreading the data and adding the direction code using its allocated spread sequence, a modulator (9) for modulating the signals onto a carrier frequency, an amplifier (22) to adjust the input level required at the receiving end for optimum correlator performance, and a physical coupler (10) for feeding the spread and direction-coded data stream into the low-voltage line (2) and forwarding it to the repeater unit (7) or network interworking unit (8).

19. The arrangement according to any one of the preceding claims 16 through 18, characterized in that the layout of the repeater unit (7) is basically similar to that of the user terminal (6) but the repeater units and parts of the clock generating unit and the synchronization unit may optionally be configured in accordance with the number of channels to be regenerated multiplied by the number of signaling directions, and the error-corrected data signals are fed from the channel decoder into the next channel encoder either directly or via a switching matrix (41), and in that a value memory (37) managed by the microprocessor (31) or a customer-specific circuit is provided in which the current channel assignments and the associated direction codes and sequence to be used as well as other signal source and sink information are stored.

20. The arrangement according to claim 19, characterized in that the repeater unit (7) is designed for use in local

distributor boxes (3) and comprises additional physical couplers, modulators, demodulators, controllable output and low-noise input amplifiers, controlling facilities for transmit and receive signals and frequency separators or filters depending on the number of network areas to be covered.

21. The arrangement according to claims 19 and 20, characterized in that the CDMA processor (18) of the repeater unit (7) that is connected to an equalizer or fault signal suppressing unit (24) on its receive side comprises an integrator (12) and a threshold detector (13) for retrieving the data transmitted, and that the regenerated data signal is multiplied with a spread sequence (19) in said CDMA processor (18) and a direction code (20) of the user terminal (6) to be addressed or the repeater unit (7).

22. The arrangement according to one of the preceding claims 16 through 21, characterized in that the layout of the network interworking unit (8) is basically similar to that of the repeater unit (7) but that the functional groups of digital signal processing (18, 24, 25) and the clock generator (32) are configured as multiple units, at least in accordance with the simple number of transmission channels provided to the higher order telecommunication facility (48) plus the number of synchronization channels required for each low-voltage line, and that physical couplers and front ends to low voltage are provided in accordance with the number of low-voltage areas to be covered, and in that a microprocessor system is provided for channel assignment and configuration of the switching matrix (41) and CDMA processors.

23. The arrangement according to claim 22, characterized in that a device ID unit and a value memory for storing the data of all active connections consisting of routing information, channel assignment, signal quality, user terminal ID, services used, and the assigned transmission channel, are assigned to the higher order telecommunication switching center.

24. The arrangement according to one of the preceding claims 16 through 21, characterized in that the repeater units (7) are placed in or close to local line distributor boxes (3), lamp posts, and house connection boxes the distance between repeater units being about 100 m or considerably smaller in areas of great attenuation.

25. The arrangement according to one of claims 16 through 24, characterized in that the higher order telecommunication network (48) includes a home location register (49) and a visitor location register (50) for managing a partly mobile service, a check register (60) for subscriber authorization, a check register (61) for registration of approved terminals, monitoring stations (52) for monitoring data exchange of network interworking and repeater units (8, 7) as regards traffic load, quality and availability, a switching network (56) for forwarding calls from the low-voltage system to a transit point (57) or the initialization channels to the microprocessor system (38), a server (51) for selecting the shortest routes (58) to the subscriber, and a microprocessor unit (59) for determining the optimum route from the switching center to the subscriber.

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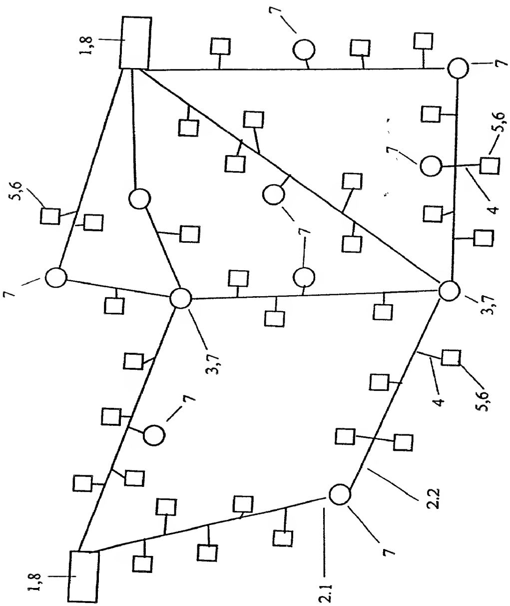

Fig. 1

09/806784

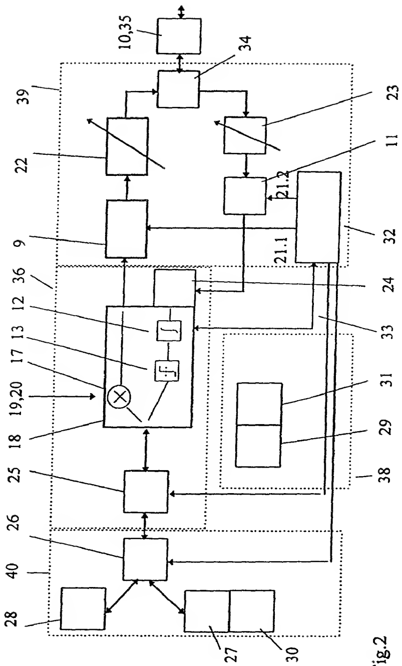

Fig.2

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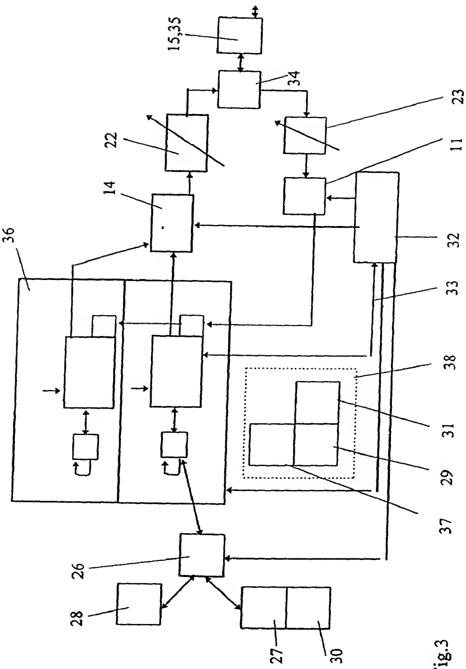

Fig.3

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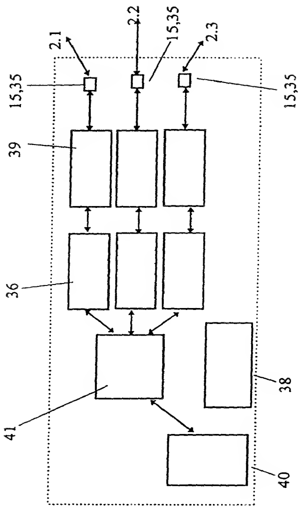


Fig.3a

09/806784

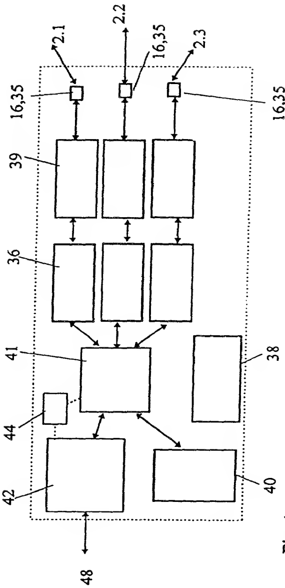
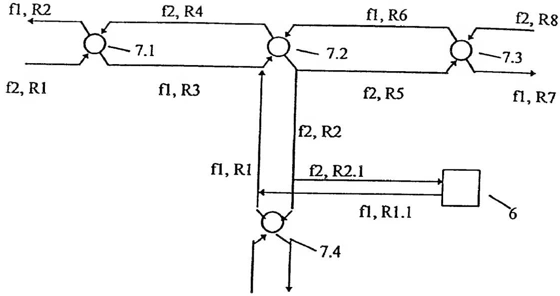


Fig.4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f2, R4
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f2, R8
7.1
7.2
7.3
f2, R1
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f2, R5
f1, R7
f2, R2
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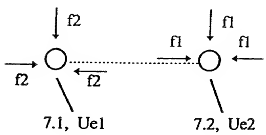
f1, R1.1
6
7.4
f2, R3
f1, R4

Fig. 5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f1
f1
f1
f2
f2
7.1, Ue1
7.2, Ue2

Fig. 6

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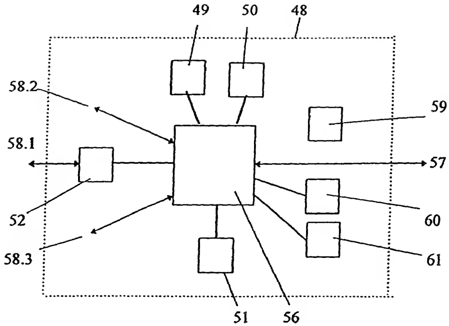

Fig. 7

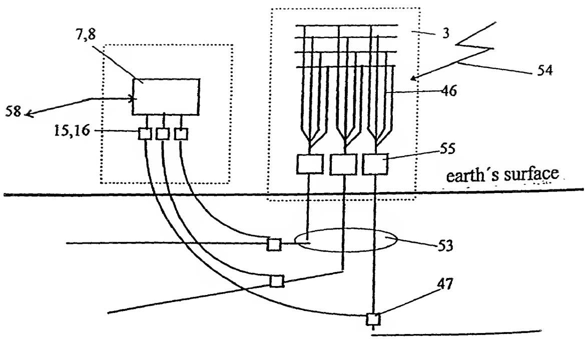

Fig. 8

Attorney Docket No. ZIMM0001

DECLARATION FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name;

I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD AND DEVICE FOR TRANSMITTING DATA OVER LOW-VOLTAGE NETWORKS

the specification of which (check one) __is attached hereto, or _X_ was filed on _______________ as Application Serial No. _______________ and was amended on _______ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, Section 1.56(a).

==

I hereby claim foreign priority benefits under Title 35, United Sates Code, Section 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed Yes	No
PCT/DE99/03154	PCT	28 SEPTEMBER 1999	X	
Number	Country	Day/Month/Year Filed		
198 46 151.8	DE	1 OCTOBER 1998	X	
Number	Country	Day/Month/Year Filed		

==

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith:

MICHAEL A. GLENN, Reg. No. 30,176
DONALD M. HENDRICKS, Reg. No. 40,355
KIRK WONG, Reg. No. 43,284
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5

SEND CORRESPONDENCE TO:

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==

Attorney Docket No. ZIMM0001

I hereby claim the benefit under Title 35, United States code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, Section 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

Application Ser. No.	Filing Date	Status: Patented, Pending, Abandoned

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor: Frank BRANDT

Inventor's signature Frank Brandt 25/04/01
Date

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(Document title)

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Pages 1 to 8 of specification are claim.

☐ ***Scanned copy is best available.***